Amendments to the Claims

Please amend Claims 1-3, 8-13, and 18-29. Please cancel Claims 31-64 without prejudice to file a continuation patent application directed to those claims. The Claim Listing below will replace all prior versions of the claims in the application:

Claim Listing:

1. (Currently amended) A computer-implemented method for modeling a non-linear empirical industrial process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non-linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process.

2. (Currently amended) The method of Claim 1, wherein the step of creating the initial model includes specifying a general shape of a gain trajectory for the non-linear empirical industrial process.

3. (Currently amended) The method of Claim 1, wherein the step of creating the initial model includes specifying a non-linear transfer function suitable for use in approximating the non-linear empirical industrial process.

4. (Original) The method of Claim 3, wherein the non-linear network includes interconnected transformation elements and the step of constructing the non-linear network includes incorporating the non-linear transfer function into at least one transformation element.

5. (Previously presented) The method of Claim 4, wherein the step of calibrating the non-linear model includes setting constraints by taking a bounded derivative of the non-linear transfer function.

6. (Original) The method of Claim 5, wherein the non-linear transfer function includes the log of a hyperbolic cosine function.

7. (Previously presented) The method of Claim 1, wherein the non-linear network model is based on a layered network architecture having a feedforward network of nodes with input/output relationships to each other, the feedforward network having transformation elements; each transformation element having a non-linear transfer function, a weighted input coefficient and a weighted output coefficient; and the step of calibrating the non-linear network model includes constraining the global behavior of the non-linear network model to a monotonic transformation based on the initial input by pairing the weighted input and output coefficients for each transformation element in a complementary manner to provide the monotonic transformation.

8. (Currently amended) The method of Claim 1, wherein the step of calibrating the non-linear network model comprises adjusting the calibration based on information provided by an advisory model that represents another model of the non-linear empirical industrial process that is different from the initial model, the non-linear network model, and the constrained model.

9. (Currently amended) The method of Claim 8, wherein the advisory model is a first principles model of the non-linear empirical industrial process.

10. (Currently amended) A computer-implemented method for modeling a non-linear empirical industrial process, and controlling a greater process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non-linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process, the non-linear empirical industrial process being part of the greater process, and deploying the constrained model in a controller that controls the greater process.

11. (Currently amended) A computer apparatus for building a model for modeling a non-linear empirical industrial process, comprising:

a model creator for creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non-linear function, an initial input and an initial output, the global behavior being at least in regions of sparse initial input;

a model constructor coupled to the model creator for constructing a non-linear network model based on the initial model, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output; and

a calibrator coupled to the model constructor for calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a

bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process.

12. (Currently amended) The computer apparatus of Claim 11, wherein the model creator specifies a general shape of a gain trajectory for the non-linear empirical industrial process.

13. (Currently amended) The computer apparatus of Claim 11, wherein the model creator specifies a non-linear transfer function suitable for use in approximating the non-linear empirical industrial process.

14. (Original) The computer apparatus of Claim 13, wherein the non-linear network includes interconnected transformation elements and the model constructor incorporates the non-linear transfer function into at least one transformation element.

15. (Previously presented) The computer apparatus of Claim 14, wherein the calibrator sets constraints by taking a bounded derivative of the non-linear transfer function.

16. (Original) The computer apparatus of Claim 15, wherein the non-linear transfer function includes the log of a hyperbolic cosine function.

17. (Previously presented) The computer apparatus of Claim 11, wherein the model constructor constructs the non-linear network model based on a layered network architecture having a feedforward network of nodes with input/output relationships to each other, the feedforward network having transformation elements, each transformation element having a non-linear transfer function, a weighted input coefficient and a weighted output coefficient; and

the calibrator constrains the global behavior of the non-linear network model to a monotonic transformation based on the initial input by pairing the weighted input and output coefficients for each transformation element in a complementary manner to provide the monotonic transformation.

18. (Currently amended) The computer apparatus of Claim 11, further comprising an advisory model that represents another model of the non-linear empirical industrial process that is different from the initial model, the non-linear network model, and the constrained model; and

wherein the calibrator adjusts the calibration based on information provided by the advisory model.

19. (Currently amended) The computer apparatus of Claim 18, wherein the advisory model is a first principles model of the non-linear empirical industrial process.

20. (Currently amended) The computer apparatus of Claim 11, wherein the non-linear empirical industrial process is part of a greater process managed by a controller coupled to controller optimizer, and the controller optimizer communicates the constrained model to the controller for deployment in the controller.

21. (Currently amended) A computer program product that includes a computer usable medium having computer program instructions stored thereon for building a model for modeling a non-linear empirical industrial process, such that the computer program instructions, when performed by a digital processor, cause the digital processor to:

create an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non-linear function, an initial input and an initial output;

construct a non-linear network model based on the initial model, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrate the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients, the global properties used to produce, via a constrained nonlinear

optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process.

22. (Currently amended) A computer-implemented method for building a model for modeling a polymer process, said method comprising the steps of:

specifying a base non-linear function for an initial model generally corresponding to the polymer process to be modeled, the initial model including an initial input and an initial output and the base non-linear function including a log of a hyperbolic cosine function;

constructing a non-linear network model based on the initial model and including the base non-linear function, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output; and

calibrating the non-linear network model based on empirical inputs of the ~~non-linear empirical~~ polymer process by using a bound on a derivative of the base non-linear function to constrain parameters of the model in order to produce a constrained model with global behavior, the constrained model providing optimized approximations to a process controller for controlling the polymer process.

23. (Currently amended) A computer apparatus for building a model for modeling a polymer process; comprising:

a model creator for specifying a base non-linear function for an initial model generally corresponding to the polymer process to be modeled, the initial model including an initial input and an initial output and the base non-linear function including a log of a hyperbolic cosine function;

a model constructor coupled to the model creator for constructing a non-linear network model based on the initial model and including the base non-linear function, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output; and

a calibrator coupled to the model constructor for calibrating the non-linear network model based on empirical inputs of the ~~non-linear empirical~~ polymer process by using a

bound on a derivative of the base non-linear function to constrain parameters of the model in order to produce a constrained model with global behavior, the constrained model providing optimized approximations to a process controller for controlling the polymer process.

24. (Currently amended) A computer program product that includes a computer usable medium having computer program instructions stored thereon for building a model for modeling a polymer process, such that the computer program instructions, when performed by a digital processor, cause the digital processor to:

specify a base non-linear function for an initial model generally corresponding to the polymer process to be modeled, the initial model including an initial input and an initial output and the base non-linear function including a log of a hyperbolic cosine function;

construct a non-linear network model based on the initial model and including the base non-linear function, the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output; and

calibrate the non-linear network model based on empirical inputs of the ~~non-linear empirical~~ polymer process by using a bounded derivative of the base non-linear function to constrain the parameters of the model in order to produce a constrained model with global behavior, the constrained model providing optimized approximations to a process controller for controlling the polymer process.

25. (Currently amended) A computer-implemented method for modeling a non-linear empirical industrial process, the method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non-linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input or in regions of missing initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on a derivative of the base non-linear function to constrain parameters of the model to produce a constrained model with global behavior of the non-linear network model, the constrained model enabling precision control of the non-linear empirical industrial process.

26. (Currently amended) A computer implemented method for modeling a non-linear empirical industrial process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated and manipulated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non linear empirical industrial process.

27. (Currently amended) A computer implemented method for modeling a non-linear empirical industrial process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global

behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated and manipulated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process, and the model coefficients being manipulated by using a modified base non-linear function.

28. (Currently amended) A computer implemented method for modeling a non-linear empirical industrial process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated and manipulated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non-linear empirical industrial process, and the model coefficients being manipulated by using a modified base non-linear function that excludes at least one of a hyperbolic tangent function, a radial basis function, and a

sigmoid function, the base non-linear function has a global minimum or a global maximum first derivative that is independent of the model coefficients.

29. (Currently amended) A computer implemented method for modeling a non-linear empirical industrial process, said method comprising the steps of:

creating an initial model generally corresponding to the non-linear empirical industrial process to be modeled, the initial model having a base non linear function, an initial input and an initial output;

constructing a non-linear network model based on the initial model, the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output, the global behavior being at least in regions of sparse initial input; and

calibrating the non-linear network model based on empirical inputs of the non-linear empirical industrial process by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated and manipulated directly from model coefficients, the global properties used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior, the constrained model enabling precision control of the non linear empirical industrial process, the global maximum and minimum values of the analytical derivatives both being a free function of the model coefficients.

30. (Previously presented) The computer implemented method of Claim 29, wherein the base nonlinear function excludes at least one of a hyperbolic tangent function, a radial basis function, a sigmoid function, and wherein a global minimum or a global maximum first derivative is independent of the model coefficients.

31-64. (Cancelled).